PHYSICAL AND CHEMICAL CHANGES IN LIVING SYSTEMS
Pre-AP Seventh Grade Science
2011-2012

Description

Matter is composed of different combinations and arrangements of atoms of elements which combine to form compounds. Matter can be subdivided into organic, carbon-containing compounds, or inorganic compounds, all atoms. These compounds can be changed physically or chemically. A physical change occurs when the physical properties of matter are altered. Physical changes do not change the composition of a substance, they only change its appearance. Chemical properties include properties which describe how matter can be changed into a new substance with new properties as a result of a chemical reaction. During a chemical reaction, atoms and molecules are rearranged, but never lost. Therefore, mass is conserved. Adding energy to matter causes the atoms and molecules from which it is made to increase in motion. Increased molecular motion may result in a change of phase, which is a physical change. Different substances have different phase change temperatures, which can be represented by a phase change diagram. Matter can be physically combined to form mixtures. One type of mixture is called a solution. A solution is a homogeneous mixture that may be formed when one substance is dissolved in another without the occurrence of a chemical reaction. Concentration of the solution depends on how much of the solute is dissolved. Emphasis in this unit is placed on the idea that mass is never lost or gained, even though physical or chemical properties may change.

Connections

Matter is made of atoms which can combine to form compounds. Changes in matter may be physical, where only appearance changes, as illustrated when compounds are combined into a solution. Changes in matter may also be chemical in nature, where atoms are rearranged to make a new substance with new properties, such as when vinegar and baking soda are combined and create a gas.. In order for both types of changes to occur, energy is required. The transfer of energy among living organisms is discussed in a unit titled “Energy and Life Processes.” More information about human body systems and their energy requirements are also addressed in a previous unit, as are cellular processes that use and release energy.

Enduring Understandings

1. Matter is anything that has mass and takes up space. Matter is made of atoms of elements. All the known elements are listed in the Periodic Table of the Elements.
2. Atoms and molecules (groups of atoms) may be chemically combined to form compounds.
3. A compound is a pure, homogeneous substance consisting of atoms of two or more different elements in definite proportions that cannot be separated by physical means. A compound usually has properties that are different from the elements from which it is made.
4. Organic compounds contain the element carbon, along with other elements such as nitrogen, oxygen, hydrogen, phosphorus, and sulfur. Organic compounds necessary for life include carbohydrates, proteins, lipids, and vitamins.
5. An inorganic compound is any substance in which two or more chemical elements other than carbon are combined in definite proportions. Some inorganic compounds contain carbon, but lack the chemical bonding necessary in organic compounds (e.g., carbonates). Inorganic substances necessary for life include water and minerals.
6. Compounds are consumed, and then broken down during the process of digestion, in order to provide an organism with nutrients necessary for growth and development.

7. Physical properties include observable characteristics such as color, size, phase, mass, volume, and density. Changes in these physical properties alter the appearance of matter, but not its composition.
8. Chemical properties include flammability as well as the ability of two substances to react to form a new substance, resulting in different properties. Evidence of chemical changes may include one or more of the following: a change in color and/or temperature, the formation of bubbles, and/or the creation of a new smell.
9. When a solid melts into a liquid, or a liquid vaporizes into a gas, energy is being absorbed, and therefore molecular motion increases.
10. When a gas condenses into a liquid, or a liquid freezes into a solid, energy is being released, and therefore molecular motion decreases.
11. The freezing and melting points of a substance are the same temperature, as are the vaporization and condensation points.
12. A solution is a homogeneous mixture. In a solution, the solute is the substance to be dissolved, and the other is a solvent. The solvent is the substance doing the dissolving. There is usually more solvent than solute.
13. Solutions may be dilute, saturated, or supersaturated depending on how much solvent has been dissolved in the solution. A dilute solution is one in which more solute can be dissolved in the solvent. A saturated solution is one in which no more solute will dissolve in the solvent under ordinary conditions. A super-saturated solution is one in which more solute than usual is dissolved in the solvent due to increases in temperature or pressure.
14. Solubility refers to the ability of a substance to be dissolved. Specifically, it is the amount of a substance that can be dissolved by another substance at a given temperature and pressure.
15. Two substances that can be mixed to create homogeneous solutions are said to be miscible (e.g., alcohol and water). Two substances that will not mix evenly are said to be immiscible (e.g., oil and water). Miscibility usually refers to liquids.

Essential Questions

1. What is matter?
2. What is the difference between organic and inorganic compounds?
3. How does the human body use organic compounds for growth and development?
4. What is the difference between physical and chemical properties? Physical and chemical changes?
5. How does the Law of Conservation of Mass relate to chemical changes?
6. Why does matter change phases?
7. Why do different compounds have different phase change temperatures?
8. How can phase changes be graphically represented?
9. What is a solution and how is it made?
10. How is solubility related to temperature and pressure?
11. How can the concentration of a solution differ?
12. How does the Law of Conservation of Mass relate to solutions?
13. What is miscibility?

Essential Concepts and Skills

By the end of the unit, the student is expected to:

1. trace the origins of a compound back to its roots on the Periodic Table of the Elements
2. classify organic and inorganic compounds
3. model the difference between mechanical and chemical digestion
4. describe and illustrate how the digestive process breaks down organic molecules for use in growth and development
5. compare and contrast physical and chemical changes

6. draw and interpret a phase change diagram
7. predict factors that might affect the phase changes of a substance
8. compare and contrast the properties of a substance during different phases
9. design an experiment to explore phase changes
10. differentiate between phase changes and chemical reactions
11. illustrate the Law of Conservation of Mass
12. distinguish between homogeneous and heterogeneous mixtures
13. identify the solute and solvent for a given solution
14. demonstrate the solubility of different substances at different temperatures
15. model different concentrations of a solution (dilute, saturated, supersaturated)
16. design an experiment to test the solubility of a substance
17. prove that mass is conserved but volume is not

What do students typically have as misconceptions?

1. When things dissolve they "disappear."
2. Melting and dissolving are synonymous.
3. Relative particle spacing among solids, liquids, and gases is incorrectly perceived and not generally related to the densities of the states.
4. Gases are not matter because most are invisible.
5. Particles are altered or lost during a chemical change, not just rearranged.
6. The temperature of an object drops when it freezes.
7. Mass and volume, which both describe an "amount of matter," are the same property.

Preconception Survey

1. What is matter and what is it made from?
2. What happens when water melts or turns to steam?
3. What happens when you stir sugar into a glass of tea?

Formative Assessment Items

1. Construct a phase change diagram by creating an investigation to observe the phase changes of a substance.
2. Compare and contrast phase change diagrams of several different substances.
3. Grow and dissolve sugar crystals to prove that crystallization is a phase change and not a chemical change
4. Design and conduct an investigation to compare the solubility of salt and sugar at different temperatures.
5. Conduct an investigation to compare mechanical versus chemical digestion.
6. Investigate the digestion of proteins, carbohydrates, and lipids.
7. Predict the volume and mass of solutions composed of two different liquids; at least one solution should be made of water and ethanol

TEKS Covered

7.6 Matter and energy. The student knows that matter has physical and chemical properties and can undergo physical and chemical changes. The student is expected to:

A) identify that organic compounds contain carbon and other elements such as hydrogen, oxygen, phosphorus, nitrogen, or sulfur. ***Supporting Standard-Category 1***

B) distinguish between physical and chemical changes in matter in the digestive system. ***Supporting Standard-Category 1***

C) recognize how large molecules are broken down into smaller molecules such as carbohydrates can be broken down into sugars.

College Board Standards Covered

PS-PE.3.1.2 Investigate a change of state of a given substance (e.g., water, wax).

PS-PE.3.1.2a Develop an appropriate method of changing the state of a substance.

PS-PE.3.1.2b Identify the initial state of the substance, and record detailed observations, including the temperature and the amount of substance in the container.

PS-PE.3.1.2c Identify the observed final state of the substance. Compare and contrast the behavior and properties of the substance in different states.

PS-PE.3.1.2d Make a claim, based on data from the investigation, about a factor that could change the results.

PS-PE.3.1.3 Given a simple chemical reaction, such as the combination of baking soda and vinegar:

*[**BOUNDARY:** Students are not expected to write chemical formulas or to balance chemical reactions. All reactions at the 6–8 grade band are assumed to be in closed (isolated) systems.]*

PS-PE.3.1.3a Record detailed observations.

PS-PE.3.1.3b Predict the relationship between the starting mass and the ending mass.

PS-PE.3.1.3c Make a claim, based on observations, concerning whether a chemical reaction or a change of state occurred.

PS-PE.3.1.3d Plan an investigation of an observed change to address the variables involved with the change.

PS-PE.3.2.3 Given a solid (e.g., sugar, table salt) and water:

*[**BOUNDARY:** Students are not expected to write chemical formulas or to balance chemical reactions.]*

PS-PE.3.2.3a Determine the amount of solid that can dissolve in the water at room temperature.

PS-PE.3.2.3b Construct a representation of the change that takes place when the solid dissolves in the water.

PS-PE.3.2.3c Predict, based on the starting mass of the substances, the ending mass. Justification includes a discussion of the law of conservation of mass and of the particulate nature of matter.

PS-PE.3.2.5 Investigate a change in mass and volume when two miscible liquids (e.g., ethanol and water) are mixed.

PS-PE.3.2.5a Follow a structured protocol to gather and record data on the masses and volumes of the given liquids before and after mixing.

PS-PE.3.2.5b Make a claim, using the data as evidence, concerning whether mass and volume are conserved when a change occurs.

PS-PE.3.2.5c Explain, using representations, why mass is always conserved and why volume may not be conserved.

Vocabulary

mass, matter, atoms, elements, molecules, compounds, physical properties, chemical properties, physical changes, chemical changes, organic compounds, inorganic compounds, carbohydrates, proteins, sugars, lipids, vitamins, Periodic Table of elements, mechanical digestion, chemical digestion, homogeneous mixture, heterogeneous mixture, flammability, sublimation, solubility, condensation, evaporation, freezing, melting, dissolved, dilute, solution, saturated, miscible, Law of Conservation of Mass